The Role of Smart Grid in Systems Integration

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16 May 2016, Kgs. Lyngby
The UK-Nordic Smart Grid Forum:
A Whole Systems Approach to the Smart Grid
Renewable Energy in Europe

EU targets for 2030:
- A 40% cut in greenhouse gas emissions compared to 1990 levels
- At least a 27% share of renewable energy consumption
- At least 27% energy savings compared with the business-as-usual scenario
Wind Power in Denmark

Year 2014
Danish wind power generation: 39.1% of the electricity consumption

January 2014
Danish wind power generation: 63.3% of the electricity consumption

December 21\textsuperscript{th} 2013
Danish wind power generation: 102% of the electricity consumption

Single hour July 9\textsuperscript{th} 2015
Danish wind power generation: 140% of the electricity consumption

March 11\textsuperscript{th} 2014
\textit{only} 9 MW wind power generated out of installed 4,900 MW
\textit{but} 480 MW out of 580 MW solar units supplied the grid

Source: Nord Pool Spot and Energinet.dk
Strong Interconnectors

- **AC**
  - Under construction
  - Planned
  - Existing

- **DC**
  - 700 MW
  - 1000 MW
  - 740 MW
  - 700-1400 MW

- Nordic area:
  - NO: Statnett
  - SE: Svenska Kraftnät

- Continental Europe:
  - UK area: National Grid
  - GB
  - NL: TenneT
  - DE
  - 50Hertz
  - 400 MW

- UK area to Continental Europe:
  - Viking Link
  - COBRAcable

- Continental Europe to Nordic area:
  - Skagerrak 4
  - Kriegers Flak

- Power Capacities:
  - 700 MW
  - 600 MW
  - 400 MW
The Krieger’s Flak Offshore Farm combining WPP connection and interconnection Denmark-Germany

- A step toward an offshore grid

- Important research challenges
  - Coordinated protection and control of WPP. HVDC and grid connection
  - Interaction between market and operation
  - Optimal utilization of the grid
Why Smart?

• Cost-efficient green transformation of the energy system

• Increased need for integration and coordination of energy infrastructures
  – electricity, heating, cooling, gas

• Opportunities offered by information and communication technology and rapid development in distributed energy technologies
  – Sensors (IoT)
  – Artificial intelligence (AI)
  – Mobile internet
  – Cloud services
  – Open data/big data
  – Sharing economy
  – eMoney
  – Energy storage (batteries)
  – Electrical vehicles
  – Solar Power
Energy System Integration across Multiple Scales

Data Pathway: Information and communication technologies allow a better understanding and control of systems by linking sensor data from multiple locations to control centers.

Ref.: CITIES project
EcoGrid EU
Large-scale Demonstration of a Prototype for European Smart Grids

- 2,000 active private and commercial customers
- EU fast-track to Smart Grids
- Period: 2011-15
- Budget: 21 million Euro
- Integrated research and demonstration

IEA ISGAN Award of Excellence in smart grid systems "Consumer Engagement & Empowerment", 2014.

"Best Sustainable IT-project", 2012 awarded by Sustainia 100 (Arnold Schwarzenegger et. al).

Refs: IEEE Transactions on Smart Grid, 2013. ... and others.
Demand response to step in price (other effects excluded)

Demand response for automated groups

- IBM heat pumps
- IBM electric heating
- Siemens electric heating
iPower: Strategic Platform for Innovation and Research headed by CEE
30+ industrial/academic partners, 5 years, 16 M€
iPower FLECH

DSO Services:
- Load Management
- Voltage Management

Planning
- Generate load profiles
- Estimate Grid loadflow

Scheduling
- Derive flexibility demand
- Update load schedule

Operation
- Operate grid

Settlement
- Metering

DSO

FLECH

Aggregator
- Forecast flexibility
- Aggregate & optimize flexibility
- Dispatch plans and reserve
- Operate plans and activation
- Settle flexibility

Request
- Bid
- Contract
- Activation
- Provision
- Payment
Savings due to reduced fuel and CO2 costs together with peak power investments

Reduces 20 of 45 GW new peak capacity

Socio-economic value of 2 bill. EUR/year (113 mill. EUR/year) in NWE (Denmark) due to flexibility
Kan vi elektrificere Danmarks olieindsbyer?

Stor årlig besparelse
Med en startinvestering på 0 kr., sparer skolen 15 pct. på varmeregningen, hvilket svarer til omkring 40.000 kr. om året

Stor CO₂ reduktion
Varmen der bliver leveret er baseret på vindkraft og omgivelsesvarme, og er dermed 100 pct. CO₂ neutral

Sætter skub i den grønne omstilling
Inden for 9 mdr. har Best Green konverteret 20 pct. af olieforbruget i Hylke til varmepumper
Grøn mobilitet kan gøres gratis!?  
www.tadaacar.dk

- Ladeinfrastruktur
- P-pladser
- Dagligt vedligehold

- Markedsføringsaftaler
- Datakøb
- Energiservice aftaler

- Reklamekunder
- Sponsors
- Datakunder
- Balanceansvarlige i El-nettet

- BASIS
- FLEX
- GO
- FRIHED

- Mobilitet

- Biler
- Bookingplatform
- Social platform
- Forsikring/vejhjælp
- Drift og service
Det handler engrosmodellen om - betalingsstrømme

**I DAG**

1. led
Elforbruger

2. led
Elhandel
Energi A/S

3. led
Net A/S

4. led
SKAT

DATAHUB = FORBRUGSDATA

**NYT**

1. led
Elforbruger

2. led
Elhandel
Energi A/S

3. led
Net A/S

4. led
SKAT

DATAHUB = FORBRUGSDATA  PSO  AFGIFTER  BETALING
Adoption of Digitalization in Different Industries

EXHIBIT 1 | Industries Are at Different Stages in the Adoption of Digital Technology

- **MEDIA**
  - Fully digitized players own the market with online stores and services such as Amazon and Netflix

- **RETAIL**
  - Online retailers gaining market share, especially in segments like electronics

- **TELECOM, INSURANCE, AND BANKING**
  - Digital has been a major focus in all three industries, with both customer-facing initiatives (such as online offerings/stores) and back-office improvements

- **CONSUMER PACKAGED GOODS**
  - No major digital disruptions yet; most initiatives have been in supply chain management and product development

- **AUTOMOTIVE**
  - Optimization mainly in supply chain management and customer-facing ventures such as websites

- **LOGISTICS**
  - Few disruptive players; some digital optimization, such as route optimization in parcel delivery, but little digital in shipping

- **HEALTH CARE**
  - Digitization just beginning, with a few examples of front-office and R&D-focused initiatives

- **ENERGY**
  - Extremely limited use of digital, primarily in internal operations

Source: BCG analysis.
Partnership for Smart Energy Networks RDD
New report on recommendations regarding frame conditions

• Well-functioning innovation chain

• Better possibilities for support of to system integration

• Regulatory frames which support the development

• Increased international participation and interaction

• Prioritized and stable support to smart energy